Arrangement for attaching a dental instrument in the head of a handpiece and formed from an elastic belt

The present invention relates to an arrangement for attaching an instrument in a dental handpiece.

Many arrangements for attaching dental instruments in handpieces are known, in particular those designed to keep, by catching, an instrument in a head in which the instrument is guided rotationally by separate means. This is for example the case of the arrangement such as that described in patent EP 0 174 695. These arrangements generally make use of the radial displacement of shoe-type mechanical components that cooperate with a groove shape made on the handle of the instrument into which they fit, said shoes being held in place or returned by a spring system.

These embodiments, apart from the fact that they are expensive because they make use of many parts, are bulky and make the dimensions of the head large.

However, the current development in microscope dentistry requires the smallest possible instruments.

It is an object of the invention to propose an instrument attachment arrangement that allows the production of a handpiece head of small dimensions and low cost, which is detachable and applicable to straight and counter-angled handpieces.

This object is achieved by the invention, which consists of an arrangement for attaching a dental instrument to a tool-holder assembly for the attachment and rotational driving of a dental tool or instrument about a driving axis, said tool-holder assembly being integrated into a head of a dental handpiece and connected to a movement transmission assembly integrated in a handle of said handpiece, characterized in that it is composed principally of a deformable and elastic tightening and releasing means in the form of a belt, of which at least one part exhibits a section adapted to engage in an annular slot or groove that is provided in the upper part of the instrument and is

adapted to retain said instrument by tightening forces, said tightening and releasing means also comprising means for the application of releasing forces for canceling out the tightening forces for the purpose of releasing the instrument.

Preferably, the tightening forces are due to the elasticity of the material or to the elasticity of the handpiece and are exerted perpendicular to the axis of the instrument preferably at diametrically opposed points thereof.

According to one embodiment, the belt made of a deformable elastic material exhibits a form that is essentially that of a parallelogram having a central zone provided for the purpose of retaining the head of the instrument tightly in place in a slot, the large diagonal of the parallelogram being provided in order to ensure that its two extremities extend diametrically beyond the envelope of the head as two projections, each located in a notch in the head, the two projections constituting means for the application of forces, manually and directly, for releasing the belt.

Furthermore, the belt comprises detachments provided in the proximity of the projections and resting on the periphery of a housing provided in the head for accommodating the attachment arrangement.

According to another embodiment, the elastic belt in the form of a parallelogram and having a central zone provided in order to retain the instrument tightly in place comprises two lugs forming projections perpendicular to the plane of the belt and situated on the same side as the latter, which two lugs constitute means for the application of tightening forces via the intermediary of a barrel-pinion positioned on the head of the handpiece.

According to this embodiment, the attachment arrangement also comprises a push-button made of a plurality of component parts, namely:

- an elastic ring at the lower extremity, which

retains the push-button on the head,

- an intermediate elastic zone, which plays the role of a return spring of the push-button,
- an internal cylindrical insert, which, when the push-button is pressed, causes the elastic belt to deform, thereby releasing the tool.

Furthermore, the insert has an internal conical form in order to interact with conical sidewalls of the lugs of the belt.

According to one and/or other of these two embodiments, the belt in the form of a parallelogram also has a conical part made on the undersurface of the central zone.

According to yet another embodiment, the deformable elastic belt exhibits the form of an elastic split ring.

More particularly, this split ring comprises an upper cylindrical flange extended by a conical intermediate part and a transverse shoulder formed by segments directed toward the driving axis.

In this embodiment, the push-button has, on the undersurface, clipping hooks for interacting with slots of a barrel-pinion, rotating the instrument.

Moreover, the attachment arrangement according to the invention may be applied to any type of straight or counter-angled handpiece and is not limited to the type of handpiece with a one-piece body presented by way of nonlimiting example in the following description.

The invention will be appreciated more easily with the help of the description below, in conjunction with which reference is made to the following accompanying Figures:

- Figure 1: a general view in three dimensions of a handpiece in accordance with the invention,
- Figure 2: a view as a longitudinal section of

the handpiece in Figure 1,

- Figure 3: a view as a partial longitudinal section of a nonrestrictive embodiment of the invention,
- Figure 4: a three-dimensional representation and a partial section of another nonrestrictive embodiment comprising a tightening and releasing means in the form of a lozenge-shaped elastic belt capable of being released manually,
- Figure 5: a view as an axial section of the view in Figure 4,
- Figure 6: a view as a partial transverse section of the head in Figure 4, illustrated at the level of the elastic belt,
- Figure 7: a three-dimensional representation and a partial section of the head in Figure 4,
- Figure 8: a view as an axial section of another nonrestrictive embodiment comprising a tightening and releasing means in the form of an elastic belt capable of being released by the actuation of a push-button,
- Figure 9: a three-dimensional representation and a partial section of the embodiment in Figure 8,
- Figure 10: a three-dimensional representation of the elastic belt in Figures 8 and 9,
- Figure 11: a view as an axial section of another nonrestrictive embodiment comprising a tightening and releasing means in the form of a split ring,
- Figures 12 and 13: a three-dimensional representation of the push-button in Figure 11,
- Figures 14 and 15: a three-dimensional representation of a tightening and releasing means in the form of a split annular clip in

Figure 11,

- Figure 16: a three-dimensional representation of a push-button in Figure 3.

General concept of the body of the handpiece.

Reference is made in the first instance to the nonrestrictive examples in Figures 1 to 3.

A handpiece (1) in accordance with the invention consists of a body (2) in a single piece comprising one part serving as a handle (3) having a rectilinear axis, and one part constituting a head (4), for the attachment and driving of an instrument (5) as claimed in a driving axis (6) capable of being aligned with the axis (7) of the handle or capable of forming a predetermined angle with the latter, lying between 90 and 180°, and preferably lying between 100 and 130°, as illustrated in the nonrestrictive example in the Figures.

The body is formed by an envelope (8) or external casing, which may or may not be in a single piece, which may be electrically insulating and capable, for example, of being produced in a polymer, thermoplastic or thermosetting material (preferably polyether-ether ketone, abbreviated to PEEK in the rest of the text) incorporating the mechanical component parts of the handle and the head together with electrical connection means, ensuring the transmission of the movement and the electrical energy from a connection (9) provided at the extremity of the handle in order to interact with an external motor, not illustrated here, as far as the instrument (5) secured in the head (4).

The counter-angle handpiece (1) in accordance with the invention represented in Figures 1 to 3 exhibits two axes (6) and (7) enabling the potential for friction inherent in each bearing to be limited in order to guarantee the most stable possible output, for which reason, in this case, ball bearings are also

integrated in the envelope (8). An arrangement of the counter-angle handpiece of this kind lends itself particularly well to root canal treatments (endodonty) with an apex locator.

A handpiece in accordance with the invention that is connected and coupled to a motor may thus, for example, generate a rotational movement to an instrument (5) (a root canal instrument, for example) and by this means may even convey an electric current that is capable of being utilized for the detection of the apex. The electrical connection between the motor and the handpiece (see Figures 2 and 3) may be effected by any connection means, for example between an attachment hook for the motor and an attachment groove (10) of a socket (11) (or by means of a telescopic button, for example). The envelope (8), which is insulating, is held by the practitioner in his hand, and its extremity at the head (4) end is placed in the patient's mouth. In this configuration, the chain of mechanical transmission and electrical component parts is constituted as follows inside the handle: the electrical current passes from the socket (11) to a fixed external race of a first bearing (12), and to a first spring (13), then to a fixed external race of a second bearing (14), then to a ring (15) that is retained axially on a first shoulder in the envelope (8), and then to a spring (16) that is retained axially by a second shoulder of the envelope (8).

The first and second bearings (12, 14) support a transmission shaft along the longitudinal axis (7) of the handle, or the first axis of the handpiece (1), and the springs (13 and 16) are compression springs of which the coils are arranged externally to the transmission shaft (7).

At this stage, the electrical current has thus crossed the handle part of the counter-angle or the handpiece (1).

As a variant, it is possible to envisage a

conducting wire running from the extremity at the motor end to the contact with the instrument or tool (5).

The head (4) of the counter-angle handpiece with its second axis or drive axis (6) supports two ball bearings (with oblique contact, if possible), namely an upper bearing (17), of which the external race interacts with the second spring (16) of the handle, and a lower bearing (18), of which the axial play is taken up with the help of an elastic washer (19).

In this type of bearing assembly, the balls of the bearings are in contact at all times with the external and internal races of the latter, thereby ensuring an electrical connection between fixed parts and moving parts.

A barrel-pinion (20) mounted on the drive shaft (6) comprises teeth (21) engaging with the teeth (22) of an output pinion (23) of the handle.

The barrel-pinion (20) is conductive and integral with the interior races of the bearings, and it ensures the conduction of electricity to the instrument (5) and the mechanical driving of the latter. The electrical current that is conveyed to the extremity of the instrument will delimit the apex through the effect of variation in the resistance, taking into account the external insulation of the envelope (8) and a push-button (55) provided on the head (4), as described in greater detail below.

<u>Concept of the attachment arrangement and the means of tightening and releasing of the instrument in the head.</u>

What are described here are preferred, although not restrictive, embodiments of a means of attaching an instrument in the head (4) and their means of tightening and releasing the instrument.

In the course of root canal treatment, for example, the accessibility of the molars is a guarantee of comfort and quality both for the practitioner and

for the patient. This is why the applicant set itself the objective of proposing a tool-holder assembly (24) composed of mechanical transmission component parts of the head that should be as small and compact as possible.

The applicant has achieved its objective by conceiving:

- a new, compact and not bulky tightening and releasing means (25), being part of an attachment assembly, and consisting of a deformable and elastic belt (25) made or not made of a plastic material (PEEK, for example), and capable by itself of assuring the functions of tightening and releasing, said releasing being performed by a centripetal manual action on the belt, and said tightening being performed by relaxing this action,
- an internal housing (26) in the head, adapted to receive the tool-holder assembly (24) and its tightening and releasing means (25), said housing opening out onto the head via an opening (27) that is capable of being closed by means of a stopper or a cap (28), or by means of a push-button.

This solution will be appreciated more readily by reading the descriptions of the two embodiments given below.

A first mode of realization is described initially in conjunction with Figures 4 to 7, for which releasing is controlled by a direct manual action on the belt.

According to the housing (26) of the tool-holder assembly (24) exhibits, on the one hand, a lower, cylindrical part (29) that is coaxial with the driving axis (6) and of which the diameter is so adapted as to receive the barrel (30) of the

barrel-pinion (20), and, on the other hand, an upper, essentially cylindrical part (31), similarly coaxial with the driving axis (6) and having a larger diameter and intended to receive the teeth (21) of the barrel-pinion with its means of interlocking the instrument as well as the device for tightening and releasing the latter described below.

The discharge opening (27) of the upper part of the housing (31) is closed by means of a stopper or cap (28), preferably although not necessarily made of the same material as the envelope (8).

The upper part of the housing (31) similarly comprises a lateral opening (32) discharging into an internal housing (33) of the handle (3), in such a way as to permit the engagement of the teeth of the barrel-pinion (20) with the teeth of the output pinion (23) of the handle (3).

The barrel-pinion rotates freely in the head, and its axial standard is assured between, on the one hand, the base (34) of the upper part of the housing which forms a shoulder and, on the other hand, the frontal surface (35) of the stopper. The resulting axial freedom of said barrel-pinion is in the order of a few hundred parts of a millimeter.

The rotational movement of the output pinion (23) is transmitted to the barrel-pinion (20) and then to the instrument (5) thanks to a plane surface (36) provided on the instrument and interacting with a plane surface (37) provided in the internal bore (38) of the barrel-pinion.

As claimed in this example of Figures 4 to 7, the tightening and releasing means is composed essentially of a belt (25) made of a deformable and elastic material exhibiting the form essentially of a lozenge having a central zone (39) provided in order to retain the head (40) of the instrument securely in place at the level of an annular blocking slot (41)

provided at the upper extremity of the instrument.

The large diagonal of the lozenge is provided in order to ensure that its two extremities extend diametrically beyond the envelope of the head (4) as two projections (42), each located in a notch (43) in the head, each notch (43) discharging, on the one hand, into the upper part (31) of the housing and, on the other hand, into the opening (27) receiving the stopper.

A direct, centripetal, manual action on the two projections (42) simultaneously brings about the release of the instrument, and the relaxation of this action assures the tightening of said instrument.

The sidewalls (44) of the notches (43) ensure the blocking against rotation of the belt, which is centered in the head by means of detachments (45) provided in the proximity of the projections (42) and supported on the periphery (46) of the upper part of the housing (26).

The axial standard of the belt is assured, on the one hand, by a shoulder (47) provided in the base (48) of an axial cavity (49) of the stopper intended to accommodate the head (40) of the instrument and, on the other hand, by the base (50) of the notches.

In this way, the belt does not touch the rotating part of the barrel-pinion.

In the free state, said belt interacts with an upper shoulder (51) of the annular slot of the head of the instrument in order to bring about a first axial limitation of said instrument, the second axial limitation being assured by a plane surface (52) on the barrel-pinion interacting with the transverse extremity (53) of the plane surface of the instrument.

The unlocking of the instrument involves the application of two diametrically opposed pressing forces to the projections (42), directed towards the axis of rotation. These two forces give rise to an orthogonal component, thereby releasing the instrument.

The act of pressing simultaneously and directly on the two lugs of the belt (with the thumb and index finger, for example) guarantees tightening at the mouth compared with the push-button system, for example. Attachment of the instrument can be effected without applying pressure to the two lugs of the belt thanks to the arrangement of a conical part (64) provided on the undersurface of the central zone (39) in the belt, in conjunction with which the axial displacement of the instrument causes a radial displacement of the belt, by elasticity, and the belt resumes its form in order to assure the tightening function.

A second mode of realization of the tightening and releasing means is described below in conjunction with Figures 8 to 10.

The elastic belt (25) having the form of a lozenge and a central zone (39) for the purpose of securing the instrument differs from the preceding belt by the fact that its lugs (54) form projections perpendicular to the plane of the belt and are situated on the same side as the latter, and by the fact that it is maintained in position axially and radially by the barrel-pinion, as illustrated in Figures 8 and 9.

To this effect :

- the two extremities of the belt cross two peripheral gaps (61) provided on the upper flange (62) of the barrel-pinion, which are diametrically opposed and arranged on a plane transversal to the driving axis (6),
- the two lugs (54) are blocked against rotation by two notches (63) on said flange.

Furthermore, the head is distinguished from the preceding head in the sense that the stopper is replaced by a push-button (55) having a metallic insert, for example (to facilitate its manufacture).

As claimed in this mode of realization, the push-button, made of PEEK for example, exhibits a plurality of component parts :

- an elastic ring (56) at the lower extremity, which restricts the axial freedom of the barrel-pinion and retains the push-button on the head (4),
- an intermediate elastic zone (57), which plays the role of a return spring for the push-button,
- an internal cylindrical insert (58), which, when the push-button is pressed, causes the elastic belt to deform, thereby releasing the tool, and for this purpose a press on the push-button (55) compresses its spring (57) and causes the internal conical form (59) of the insert (58) to interact with the conical sidewalls (60) of the lugs of the belt. The resulting radial component on the lugs (54) of the belt induces another radial deformation perpendicular to this primary component. This deformation permits unlocking of the instrument.

The introduction of the instrument into the head may be effected by pressing on the push-button, or without pressing on the push-button, in which case a conical arrangement (64) on the undersurface of the central zone (39) of the belt permits the introduction of the instrument.

The configuration of the belt contributes to being able to guarantee the tightening through a centrifugal effect during rotation.

Concept of push-buttons

Miniaturization is a constant area of research in the field of medical equipment, such as the heads of the counter-angled handpieces used in dentistry. New materials, such as thermoplastic or thermosetting polymer materials, meet this challenge. Previously disclosed mechanisms may be reconsidered by taking into account the mechanical, physical and chemical

characteristics of these new materials and, at the same time, by reducing the number of component parts, improving the quality and reducing the cost of the assembly; these plastic parts may be machined or injected. In addition to miniaturization, of course, these plastic materials also bring lightness, the ability to slide for dynamic equipment, high resistance to sterilization or disinfection, and favorable elastic characteristics. That is why these plastic materials can be utilized in the production of dental handpieces. The command for tightening or releasing the tool generally takes the form of the manual actuation of the push-button on the head of the handpiece. In accordance with the concept, this push-button may be integral with the dynamic assembly (rotating, vibrating ...), for example for endodonty, and with a fixed push-button independent of the dynamic assembly.

A head of a handpiece having a bur in place has already been presented above as an example of an application, with reference to Figures 2 and 3.

It should be pointed out again here that the body of a head (4), whether or not in a single piece with the handle (3), is fitted with a rotating barrel-pinion (20) that is caused to rotate by an output pinion (23) in the handle. The barrel-pinion possesses a freedom of rotation and an axial connection that are assured, for example, by ball bearings.

It is, of course, possible to envisage solutions without the use of ball bearings, as illustrated in Figures 5 and 7, having inserted plain bearings or having plain bearings molded into the body of the head.

The transmission of the rotational movement of the bur is assured by the conjugation of the plane surface (36) provided on the barrel-pinion (4) and the plane surface (37) of the tool. The axial standard of the tool is guaranteed, in one sense, by the shoulder on the plane surface of the barrel-pinion and by the

shoulder on the complementary plane surface of the tool.

Taking this common description as the starting point, it is possible to distinguish between two types of push-button in accordance with the invention, namely:

- a push-button integral with the dynamic assembly known as the tool-holder, as indicated in Figures 3 and 16 by the reference designation (55), which solution is characterized by permanent contact between the rotating locking assembly and the push-button. In the state of rest, the push-button (55) (made from PEEK, for example) provides an axial limit for an elastic split ring (65) (made from PEEK, for example) and, at the same time, centers the latter in relation to the axis (6). The ring (65) has an externally cylindrical form, and its internal wall comprises an upper flange with a conical gradient (71) and an intermediate part in the form of a transverse shoulder (66) directed towards the axis (6). The shoulder (66) of the elastic ring (65) retains the instrument (5) in the axial direction by engaging in the annular slot (41). The push-button (55) is guided radially in the bore (38) of the barrel-pinion by one or more sectors or components (87) arranged on the undersurface of the push-button (55) and each terminated by a conical extremity for the purpose of providing the presses on the elastic ring (65). The axial displacement of the push-button (55) is limited between the upper and lower extremities of one or more gaps (68) made in the upper body of the barrel-pinion, and in which interact one or more hooks (67) provided on the undersurface

of the push-button. The elastic ring (65) applies an axial component to the push-button (55) to return it to its initial position. Thanks to their radial elasticity, due to slots (69) provided between the hooks and the sectors (87), the hooks (67) permit the "clipping" engagement of the push-button in the barrel. A press on the push-button (55) permits unlocking of the tool (5) by means of the conical parts (70) which engage in the complementary conical gradient (71) of the elastic ring in order to disengage the shoulder (66). The introduction of the instrument (5) into the barrel-pinion may take place automatically without the need to press on the push-button thanks to the conical part (73) provided on the undersurface of the elastic ring at the extremity of the shoulder (66).

In Figure 3, the tightening and releasing means is a split elastic ring that is open along a radial plane visible on the sectional plane in Figure 3, and the means of applying the releasing forces are constituted by the conical gradient (71).

- <u>a push-button independent of the dynamic assembly</u>

In the position in which the tool is held in the hand, the solution is characterized by the separation of the push-button and of the locking means.

An embodiment of this kind is illustrated by way of example in Figures 11 to 15.

In the state of rest, whether or not in dynamic regime, and without actuation of the push-button, a conical, elastic annular clip (72), retains the tool (5) axially thanks to its arms (73) (for example 6 arms) each

terminated by a shoulder (79) directed towards the axis (6). The clip (72) is integral with the rotating barrel-pinion thanks to the engagement of the peripheral projections (74) of the clip in corresponding openings (76) made in the barrel-pinion. An entirely transcurrent slot (77) in the clips permits the assembly and disassembly of the clip in the bore of the barrel-pinion, thereby imparting the necessary radial elasticity to it.

The push-button (55) is retained axially and is centered by elastic blades (75) cut into its cap in the opening (27) in the head; these blades, when assembled under tension in the head body, offer an elastic axial freedom (along the axis 6) of the push-button. Figures 12 and 13 illustrate these blades (75) in the constraint position and exhibit the clipping grooves (80) at the end of the blades for clipping the push-button (55) into the opening (27). A manual, axial press on the push-button is translated into an axial displacement of the conical base (78) of the push-button, and it then interacts with the complementary cone (82) of the internal conical cavity of the arms of the clip; releasing of the tool is then assured by the separation of the aforementioned arms and the disengagement of the shoulders (79). When the manual pressure is released, the push-button resumes its initial position, as the respective cones of the two component parts (55) and (72) are no longer in contact.

In accordance with this solution in Figures 11 to 15, the means of tightening and releasing is the elastic, conical clip (72), the shoulders (79) of which are adapted to

engage in the groove or annular slot (28) of the instrument, and the means for applying the releasing forces is constituted by the conical internal form (82) of said clip (72), the radial deformation of which is guaranteed by the slot (77).

Concept of greasing

With reference to Figure 8, which is an axial section through Figure 9 and which shows that the head includes a cavity (83) provided around or to the side of the barrel of the barrel-pinion for the purpose of containing a solid grease that is released in a small quantity on each occasion of use via an orifice (84) from the separating wall (85) between the cavity and the barrel in order to lubricate the barrel.

Assembly concept

The envelope (8) may be produced in a single piece by molding a plastic (for example PEEK), having electrically insulating properties, or a fritted material containing metallic inclusions (for example Metal Injection Moulding, abbreviated to MIM), having electrically conducting properties, or any other material. This envelope comprises:

- in the head, a first housing (26) for the attachment of a tool-holder and an instrument along a drive axis (6), which housing opens out to either side of the head via two openings, of which at least one, the opening (27), exhibits dimensions so adapted as to permit the introduction of all the component parts of the head as well as their assembly,
- inside the handle, and a second housing (33) having a rectilinear axis (7) opening out on

the one hand at the distal extremity of the handle via an opening (81) and opening out on the other hand at the proximal extremity of the head, in the first housing (26) via a lateral opening (32) permitting interaction between the mechanical components of the head and those of the handle. In addition, the opening (81) is dimensioned in such a way as to be adapted to permit the introduction of all the components of the handle as well as their assembly in the interior of the latter along a rectilinear axis referred to as the axis of the handle (7). In order to produce a counter-angled handpiece, an envelope is provided, of which the axes (6) and (9) form, for example, an angle of between 90 and 180°, and preferably between 100 and 130°, and in order to produce a straight handpiece, it is possible to stipulate that the axes (6) and (7) must be parallel and displaced from one another in such a way as to make an opening in the head (27) available for the assembly of the internal component parts and the fitment of a stopper of a push-button.

This concept is particularly advantageous because it provides the possibility of:

- reducing the number of bearings, or eliminating them,
- reducing the cost of the handpiece,
- reducing the dimensions of the handpiece,
- facilitating cleaning (smooth contours),
- improving hygiene (a single piece, and no interface).